INTELLIGENCE UPDATE

Should data centers sell their heat?


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There is an enduring idea in the industry that capturing and selling the waste heat produced by a data center can be profitable. However, after more than two decades of implementation, there is little evidence that heat can be turned into a reliable source of additional revenue for data center operators.

This poses an issue for waste heat recovery advocates: it eliminates one of the key benefits intended to compensate data center operators for the difficulties associated with running waste heat recovery programs. Some of the frequently cited problems with data center heat export include:

- Relatively low — typically 20°C to 35°C (68°F to 95°F) — temperature of outgoing facility water. This limits applications unless temperature is concentrated with expensive heat pumps that require additional energy to operate.
- Variable demand for heat that depends on the season and the needs of the end customer. Customers with predictable heat demand — such as hydroponic farms or large district heating networks — are rare.
- There is little to no redundancy in heat transport outside the facility. Even large district heating networks with a degree of systemic redundancy can go down — and do.
- The ability to transport heat to a third party comes at a cost to data center operators. At a minimum, it requires investment in a heat transfer station with additional insulated plumbing and heat exchangers.
- Waste heat reuse increases operational complexity by introducing another collection of systems that need to be monitored and maintained.

After making the investment, data center operators are sometimes unable to sell their heat, so they give it away for free — or, more recently, pay customers (the heat off-takers) to use it.

This may sound like bad business, yet the number of data center heat reuse projects is increasing — ahead of many other promising sustainability technologies. So far in 2024, at least 28 new data centers with waste heat recovery capabilities have been announced, started construction or opened their doors to customers, most of which are located in Europe. What is motivating operators to embark on this difficult journey?

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How operators benefit

Some data center operators are being paid for their waste heat — most of the examples are in northern Europe, where the cold climate has encouraged the development of district heating networks. However, generating new revenue from heat is not the main motivator for these projects.

A more valuable benefit to operators is not running heat rejection systems all the time, which can lower or even eliminate the cost of electricity and water that is typically used to operate chillers, evaporators, economizers and other types of cooling equipment.

Waste heat recovery enables data centers to outsource their cooling, which is responsible for as much as 30% to 40% of the facility's overall power consumption. Operators still have to invest in cooling equipment for redundancy purposes, but they will expect this equipment to last longer because it is not being used whenever heat recovery is in operation.

Another major benefit is easier access to land and power in densely populated areas. Many municipalities now welcome heat reuse projects — since they help lower the carbon footprint and electricity consumption (and hence, cost) of local heating and cooling networks. One operator in Stockholm told Uptime Intelligence that heat reuse was the primary reason they were allowed to build a facility in the city.

Heat reuse also presents a strong selling point for colocation providers. It enables them to attract public sector contracts and business from large organizations with public environmental, social and governance (ESG) commitments.

Three paths to heat recovery

There are three distinct scenarios for the recapture of data center heat:

- **No heat pump**. Low-grade heat is either used internally (e.g., to heat offices or gray space) or supplied to a neighboring third party (e.g., a greenhouse or a residential or office block). This is the simplest and cheapest scenario, but the one with the lowest likelihood of the operator being paid for their heat.
- **Heat pump operated by a third party**. Warm water is supplied to a third party, such as a district heating network operator. The third party then uses heat pumps to increase the water temperature before delivering it to its own customers. Some data center operators are paid for this, while others are not — contracts can vary even among multiple operators that work with the same third party.
- **Heat pump operated by the data center**. Operators invest in heat pumps and pay for electricity to keep them running. This approach can supply higher-temperature water to customers, expanding the range of potential applications. Although it is more costly than the other scenarios, it has the highest likelihood of the operator being paid for heat export.

In theory, all three scenarios have a positive impact on PUE and the operating expenditure of

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the data center. In the first two, the operator avoids having to run at least some of their cooling equipment. Instead, warm water is transported to the boundary of the data center, where cold water is received in return. According to the ISO standard on PUE, even when an operator uses a heat pump, the energy expended on concentrating heat to a more useful temperature is not counted towards the energy consumption of the facility.

In practice, measuring the impact of heat reuse on PUE is complicated. One area that poses a problem is accounting for the cooling received from the customer, district heat network or utility. Another issue is specific to colocation, where customers are often charged according to the facility's PUE. If the data center employs heat pumps for heat reuse, its PUE would be lowered. However, the metric would not include the energy spent on concentrating the heat, which means the operator might end up having to pay for it.

In some instances, data center operators use heat pumps in a closed-loop system. This not only increases the temperature of hot water that goes through the heat exchanger but also lowers the temperature of chilled water returning. There are few metrics or standards that can be easily applied in this situation.

Operators should not overthink the impact of heat reuse on PUE. This should be calculated as normal, with total energy being measured inside the data center boundary. The PUE calculation should not include the energy required to transport and concentrate the heat or the energy used to return the cold water. Heat reuse should be measured and reported using the energy reuse factor (ERF).

Conventional thinking about heat reuse states that the data center operator would always install a full complement of cooling equipment for redundancy. So, while their operational expenditure is lower, capital expenditure is the same — or higher. However, there are exceptions: Uptime Intelligence spoke to one operator that chose to eliminate chillers from the design of their latest data center — otherwise a near-copy of another facility — thanks to a reliable heat reuse partner, a district heating network with a year-round demand.

Uptime Intelligence believes that this more opportunistic heat reuse business model, where a third party guarantees the heat removal and cooling water supply, can be economically viable for large data centers with some minimum energy demand (perhaps 100 MW or more). The data center operator would pay the third party for cooling, but that cost would be less than the combined depreciation and operating cost of a full cooling system. Operational responsibilities, contingencies and penalties would have to be spelled out in the contract. There are some industrial processes, such as biomass-based energy production and wood drying, that need a continuous supply of low- or medium-grade heat that could benefit from this relationship.

Everybody is doing it

The past 12 months have seen a flurry of new activity in data center heat recovery. One of the world's largest colocation operators, Equinix, announced a formal waste heat reuse program for

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new and existing data centers. Rival company, Digital Realty, completed its flagship facility in Paris, France, in time to heat the swimming pools during the 2024 Summer Olympics.

Microsoft has started construction of the world's largest heat reuse project in Finland, which is expected to provide enough heat to supply up to 40% of the needs of the (albeit sparsely populated) Kirkkonummi region using existing heat networks. Finland's electricity grid is one of the world's least carbon-intensive, so while the project would not displace carbon emissions, it would allow clean energy to be deployed elsewhere.

The New York State Energy Research and Development Authority announced $12 million in grants for heat recovery projects, including data center waste heat, in New York State. The body is awarding up to $2 million per project, while also funding opportunity assessments and project design. This is a rare case for the US, which has few data center heat recovery projects in operation.

The messaging around the benefits of data center heat reuse to off-takers is spreading — earlier this year, an agricultural company looking for heat reuse partners spoke with Uptime Intelligence while attending its first-ever data center industry event.

Heat reuse is increasingly of interest to regulators too, as they aim to decarbonize energy-intensive heating and cooling systems. This is most notable in the EU, where the updated Energy Efficiency Directive requires new data center projects over 1 MW to conduct, at a minimum, a feasibility study to establish whether reusing their heat in a given location is technically and commercially viable (see *Heat reuse: a management primer*). Data centers in urban environments present one of the most attractive targets for heat reuse, second only to wastewater plants, according to the trade association Euroheat & Power.

Conclusion

Waste heat reuse should be seen not as a revenue generator but as a cost-cutting measure. It would enable operators to spend less on electricity while minimizing the mechanical wear and tear on the cooling equipment, much of which would remain on standby.

The benefit to the heat off-taker is secondary; the focus should be on the benefits to the data center operator, and this has not been explored in sufficient detail. More work to define the potential operational and capital savings is required by data center designers, consultants and standards bodies.

To continue their trajectory, heat reuse initiatives will require better metrics and reporting, so the efficiency of different engineering approaches can be analyzed and compared. With the rapid growth in the number of waste heat reuse projects and the EU requiring operators to report metrics such as ERF, the next few years will provide a more solid basis for the development of waste heat reuse as a major component of data center design.

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The Uptime Intelligence View

For data center operators, the business case for heat reuse initiatives needs to rest not on potential revenue but on cost savings and capital avoidance. Unfortunately, today, such initiatives are often approached on a case-by-case basis and lack clear metrics that would help compare the effectiveness — and commercial value — of existing implementations. Identifying business models derived from real projects could help operators and heat off-takers in their dialogue.

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